# PATENT COOPERATION TREATY

# PCT



## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

| Applicant's or agent's file reference<br>9-16791-1PCT | **FOR FURTHER ACTION** | See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416) |
|---|---|---|
| International application No.<br>PCT/CA2003/001683 | International filing date *(day/month/year)*<br>03.11.2003 | Priority date *(day/month/year)*<br>03.11.2003 |
| International Patent Classification (IPC) or both national classification and IPC<br>B08B3/02 | | |
| Applicant<br>VLN ADVANCED TECHNOLOGIES INC. et al. | | |

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 7 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 11 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the opinion
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

| Date of submission of the demand | Date of completion of this report |
|---|---|
| 03.06.2005 | 28.02.2006 |
| Name and mailing address of the international preliminary examining authority:<br>European Patent Office<br>D-80298 Munich<br>Tel. +49 89 2399 - 0 Tx: 523656 epmu d<br>Fax: +49 89 2399 - 4465 | Authorized Officer<br>Jelercic, D<br>Telephone No. +49 89 2399-2941 |

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/CA2003/001683

## I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:

**Description, Pages**

1-18 as originally filed

**Claims, Numbers**

1-48 filed with telefax on 16.02.2006

**Drawings, Figures**

1-21 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

   *(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

## V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

| | | | |
|---|---|---|---|
| Novelty (N) | Yes: | Claims | 1-48 |
| | No: | Claims | |
| Inventive step (IS) | Yes: | Claims | 3, 11,12, 16, 17, 28-32, 34-36, 39, 43, 47 |
| | No: | Claims | 1,2, 4-10, 13-15, 18-27, 33, 37, 38, 40-42, 44-46, 48 |
| Industrial applicability (IA) | Yes: | Claims | 1-48 |
| | No: | Claims | |

2. Citations and explanations

   **see separate sheet**

**Re Item V.**

1 The following documents are referred to in this communication:

D1: VIJAY, M.M: "Design and development of a prototype pulsed water jet machine for the removal of hard coatings" PROC. 14TH INTERNATIONAL CONFERENCE ON JETTING TECHNOLOGY BHR GROUP CONFERENCE SERIES, no. 32, 1998, pages 39-57, XP009034788 LONDON

D2: US-A-4 821 961 (SHOOK FORREST A) 18 April 1989 (1989-04-18)

D3: US-A-3 373 752 (KIYOSHI INOUE) 19 March 1968 (1968-03-19)

D4: EP-A-0 829 311 (TOKYO SHIBAURA ELECTRIC CO) 18 March 1998 (1998-03-18)

D5: EP-A-1 016 469 (SCHNEIDER LUFTDRUCK GMBH) 5 July 2000 (2000-07-05)

D6: US-A-5 725 680 (MATHIEUS GEORGE J) 10 March 1998 (1998-03-10)

D7: GB 955 405 A (EXXON RESEARCH ENGINEERING CO) 15 April 1964 (1964-04-15)

D8: US-A-5 154 347 (VIJAY MOHAN M) 13 October 1992 (1992-10-13)

2 INDEPENDENT CLAIM 1

2.1 The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claim 1 does not involve an inventive step in the sense of Article 33(3) PCT.

2.2 The document D1 is regarded as being the closest prior art to the subject-matter of claim 1 and discloses (the references in parentheses applying to this document): an ultrasonic waterjet apparatus comprising:

a) a generator module having:

i) an ultrasonic generator for generating and transmitting high-frequency electrical pulses;

ii) a control unit for controlling the ultrasonic generator;

iii) a high—pressure water inlet connected to a source of high-pressure water;

iv) a high-pressure water outlet connected to the high—pressure water inlet;

b) a high-pressure water hose connected to the high-pressure water outlet;
c) a gun connected to the high-pressure water hose, the gun having an ultrasonic nozzle having a transducer for receiving the high— frequency electrical pulses from the ultrasonic generator, the transducer converting the electrical pulses into vibrations that pulsate a waterjet flowing through the nozzle, creating a waterjet of pulsed slugs of water, each slug of water capable of imparting a water hammer pressure on a target surface.

2.3 The subject-matter of claim 1 therefore differs from this known ultrasonic waterjet apparatus in that the control unit is able to vary the high frequency electrical pulses.

2.4 The problem to be solved by the present invention may therefore be regarded as control of the pulses.

2.5 The solution proposed in claim 1 of the present application cannot be considered as involving an inventive step (Article 33(3) PCT) for the following reasons.
Document D8 clearly states that *the rate at which the pulses are formed and their size can be controlled by respectively varying the frequency and amplitude of the ultrasonic vibrations generated by the transformer.* It would therefore be obvious to the skilled person to employ a control unit which can vary the pulses in the apparatus of claim 1.

3 INDEPENDENT CLAIM 40

3.1 The same reasoning applies, mutatis mutandis, to the subject-matter of the corresponding independent claim 40, which therefore is also considered not inventive.

4 INDEPENDENT CLAIM 41

4.1 The same reasoning applies, mutatis mutandis, to the subject-matter of the corresponding independent claim 41, which therefore is also considered not inventive.

5 INDEPENDENT CLAIM 44

5.1 The same reasoning applies, mutatis mutandis, to the subject-matter of the corresponding independent claim 44, which therefore is also considered not inventive.

6 INDEPENDENT CLAIM 45

6.1 The same reasoning applies, mutatis mutandis, to the subject-matter of the corresponding independent claim 45, which therefore is also considered not inventive.

7 INDEPENDENT CLAIM 48

7.1 The same reasoning applies, mutatis mutandis, to the subject-matter of the corresponding independent claim 48, which therefore is also considered not inventive.

8 INDEPENDENT CLAIM 33

8.1 The subject matter of independent claim 33 appears to be new with respect to the prior art.

9 INDEPENDENT CLAIM 36

9.1 The combination of documents D1 and D2 discloses the subject matter of claim 36, which is therefore considered not to meet the inventive step requirements.

10 DEPENDENT CLAIMS 2, 4-10, 13-15, 18-27, 33, 37, 38, 42, 46

10.1 Dependent claims 2, 4-10, 13-15, 18-27, 33, 37, 38, 42, 46 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of or inventive step (Article 33 (3) PCT).

11 DEPENDENT CLAIMS 3, 11, 12, 16, 17, 28-32, 34-36, 39, 43, 47

11.1 The combination of the features of dependent claims 3, 11,12, 16, 17, 28-32, 34-36, 39, 43, 47 is neither known from, nor rendered obvious by, the available prior art.

**Further remarks**

12 None of the independent claims is drafted in the two part form specified in Rule 6.3b) of the PCT.

13 Reference numerals are missing after the technical features of the claims (see Rule 6.2b) and PCT Preliminary Examination Guidelines, Chapter III, 4.11).

14 The description does not cite a document reflecting the closest background art (see Rule 5.1a) ii) PCT).

15 Although claims 1, 33 and 36 have been drafted as separate independent claims, they appear to relate effectively to the same subject-matter and to differ from each other only with regard to the definition of the subject-matter for which protection is sought. The aforementioned claims therefore lack conciseness. Moreover, lack of clarity of the claims as a whole arises, since the plurality of independent claims makes it difficult, if not impossible, to determine the matter for which protection is sought, and places an undue burden on others seeking to establish the extent of the protection. Hence, claims 1, 33 and 36 do not comply with the requirements of Article 6 PCT.

16 Although claims 40, 41, 44, 45 and 48 have been drafted as separate independent claims, they appear to relate effectively to the same subject-matter and to differ from each other only with regard to the definition of the subject-matter for which protection is sought. The aforementioned claims therefore lack conciseness. Moreover, lack of clarity of the claims as a whole arises, since the plurality of independent claims makes it difficult, if not impossible, to determine the matter for which protection is sought, and places an undue burden on others seeking to establish the extent of the protection. Hence, claims 40, 41, 44, 45 and 48 do not comply with the requirements of Article 6 PCT.

**CLAIMS:**

1. An ultrasonic waterjet apparatus comprising:

a) a generator module having:

i) an ultrasonic generator for generating and transmitting high-frequency electrical pulses;

ii) a control unit for controlling the ultrasonic generator to vary the high-frequency electrical pulses;

iii) a high-pressure water inlet connected to a source of high-pressure water;

iv) a high-pressure water outlet connected to the high-pressure water inlet;

b) a high-pressure water hose connected to the high-pressure water outlet;

c) a gun connected to the high-pressure water hose, the gun having an ultrasonic nozzle having a transducer for receiving the high-frequency electrical pulses from the ultrasonic generator, the transducer converting the electrical pulses into vibrations that pulsate a waterjet flowing through the nozzle, creating a waterjet of pulsed slugs of water, each slug of water capable of imparting a waterhammer pressure on a target surface.

2. An ultrasonic waterjet apparatus as claimed in claim 1 wherein the transducer is a piezomagnetic transducer made of a magnetostrictive material.

3. An ultrasonic waterjet apparatus as claimed in claim 2 wherein the magnetostrictive material is a Terfenol™ alloy.

4. An ultrasonic waterjet apparatus as claimed in claim 3 wherein the piezomagnetic transducer is a cylindrical core within a coil and a bias magnet.

5. An ultrasonic waterjet apparatus as claimed in claim 3 wherein the piezomagnetic transducer is a tubular core within a coil and a bias magnet.

6. An ultrasonic waterjet apparatus as claimed in claim 1 wherein the transducer is a piezoelectric transducer.

7. An ultrasonic waterjet apparatus as claimed in claim 1 further comprising a trigger for activating the ultrasonic generator to transform a continuous waterjet into a pulsed waterjet.

8. An ultrasonic waterjet apparatus as claimed in claim 7 wherein the trigger is located on the gun.

9. An ultrasonic waterjet apparatus as claimed in claim 8 wherein the gun is hand-held.

10. An ultrasonic waterjet apparatus as claimed in claim 1 wherein the generator module is mounted on wheels to be mobile.

11. An ultrasonic waterjet apparatus as claimed in claim 1 wherein the generator module further comprises a water dump valve between the high-pressure water inlet and the high-pressure water outlet and an actuator for opening and closing the water dump valve in response to a signal transmitted from a dump valve trigger located on the gun.

12. An ultrasonic waterjet apparatus as claimed in claim 11 wherein the actuator is a solenoid.

13. An ultrasonic waterjet apparatus as claimed in claim 1 further comprising an ultrasonic signal cable for relaying the electrical pulses from the ultrasonic generator to the transducer.

14. An ultrasonic waterjet apparatus as claimed in claim 1 further comprising a compressed air hose for providing compressed air to cool the transducer.

15. An ultrasonic waterjet apparatus as claimed in claim 14 wherein the ultrasonic signal cable is housed within the compressed air hose.

16. An ultrasonic waterjet apparatus as claimed in claim 14 wherein the generator module further comprises a compressed air inlet and a compressed air outlet, the compressed air outlet being connected to the compressed air hose.

17. An ultrasonic waterjet apparatus as claimed in claim 1 wherein the high-pressure water hose is sheathed in an abrasion-resistant nylon sleeve.

18. An ultrasonic waterjet apparatus as claimed in claim 1 wherein the ultrasonic nozzle has a single exit orifice.

19. An ultrasonic waterjet apparatus as claimed in claim 1 wherein the ultrasonic nozzle has a plurality of exit orifices.

20. An ultrasonic waterjet apparatus as claimed in claim 1 wherein the ultrasonic nozzle further comprises a rotating nozzle head.

21. An ultrasonic waterjet apparatus as claimed in claim 20 wherein the rotating nozzle head uses the water pressure in the nozzle to be self-rotating.

22. An ultrasonic waterjet apparatus as claimed in claim 21 wherein the ultrasonic nozzle further comprises a rotational damper to reduce the angular velocity of the rotating nozzle head.

23. An ultrasonic waterjet apparatus as claimed in claim 22 wherein the ultrasonic nozzle further comprises a pair of outer jets in fluid communication with the waterjet to provide torque to self-rotate the rotating nozzle head.

24. An ultrasonic waterjet apparatus as claimed in claim 23 comprising a single angled exit orifice.

25. An ultrasonic waterjet apparatus as claimed in claim 22 comprising a plurality of angled exit orifices.

26. An ultrasonic waterjet apparatus as claimed in claim 25 wherein the plurality of angled exit orifices generate torque to self-rotate the rotating nozzle head.

27. An ultrasonic waterjet apparatus as claimed in claim 1 wherein the transducer further comprises a microtip which acts as a velocity transformer by pulsing the waterjet.

28. An ultrasonic waterjet apparatus as claimed in claim 27 wherein the microtip is a stepped cylinder.

29. An ultrasonic waterjet apparatus as claimed in claim 28 wherein the microtip is made of a titanium alloy.

 

30. An ultrasonic waterjet apparatus as claimed in claim 27 wherein the microtip comprises a stub for connecting to the transducer, a stem for contacting and modulating the waterjet, and a flange between the stub and the stem, the flange defining a nodal plane at which the amplitude of standing waves set up at the microtip is zero.

31. An ultrasonic waterjet apparatus as claimed in claim 30 wherein the microtip further comprises an O-ring seal at the nodal plane for isolating the transducer from the waterjet.

32. An ultrasonic waterjet apparatus as claimed in claim 31 wherein the O-ring have a hardness rating of at least 85 durometer.

33. An ultrasonic nozzle for use in an ultrasonic waterjet apparatus, the ultrasonic nozzle comprising a transducer for converting high-frequency electrical pulses into mechanical vibrations that pulsate a waterjet flowing through the nozzle, creating a waterjet of pulsed slugs of water, each slug of water capable of imparting a waterhammer pressure on a target surface, the transducer comprising a microtip with a seal for isolating the transducer from the waterjet, the seal being located at a nodal plane where the amplitude of standing waves set up along the microtip is zero.

34. An ultrasonic nozzle as claimed in claim 33 wherein the microtip is a stepped cylinder.

35. An ultrasonic nozzle as claimed in claim 34 wherein the microtip is made of a titanium alloy.

36. An ultrasonic nozzle for use in an ultrasonic waterjet apparatus, the ultrasonic nozzle comprising a transducer for converting variable high-frequency electrical pulses into mechanical vibrations that pulsate a waterjet flowing through the nozzle, creating a waterjet of pulsed slugs of water, each slug of water capable of imparting a waterhammer pressure on a target surface, the nozzle comprising a rotating nozzle head.

37. An ultrasonic nozzle as claimed in claim 36 wherein the rotating nozzle head is self-rotating by the torque generated by deflecting the waterjet.

38. An ultrasonic nozzle as claimed in claim 37 wherein the rotating nozzle head has two outer jets.

39. An ultrasonic nozzle as claimed in claim 37 wherein the rotating nozzle head further comprises a damper to limit the angular velocity of the rotating nozzle head.

40. A method of cutting with an ultrasonically pulsed waterjet, the method comprising the steps of:

a) forcing a high-pressure continuous-flow waterjet through a nozzle;

b) generating high-frequency electrical pulses at a frequency that can be varied;

c) transmitting the high-frequency electrical pulses to a transducer;

d) transducing the high-frequency electrical pulses into mechanical vibrations;

e) pulsating the high-pressure continuous flow waterjet to transform it into a pulsated waterjet of discrete water slugs, each water slug capable of imparting a waterhammer pressure on a target surface; and

f) directing the pulsated waterjet onto a material to be cut.

41. A method of cleaning with an ultrasonically pulsed waterjet, the method comprising the steps of:

a) forcing a high-pressure continuous-flow waterjet through a nozzle;

b) generating high-frequency electrical pulses at a frequency that can be varied;

c) transmitting the high-frequency electrical pulses to a transducer;

d) transducing the high-frequency electrical pulses into mechanical vibrations;

e) pulsating the high-pressure continuous flow waterjet to transform it into a pulsated

waterjet of discrete water slugs, each water slug capable of imparting a waterhammer pressure on a target surface; and

f) directing the pulsated waterjet onto a material to be cleaned.

42. A method of cleaning as claimed in claim 41 further comprising the step of self-rotating a rotating nozzle head so that the pulsated waterjet strikes a larger surface area.

43. A method cleaning as claimed in claim 41 further comprising the step of splitting the pulsated waterjet into a plurality of sub-waterjets so that the sub-waterjets strike a larger surface area.

44. A method of deburring with an ultrasonically pulsed waterjet, the method comprising the steps of:

a) forcing a high-pressure continuous-flow waterjet through a nozzle;

b) generating high-frequency electrical pulses at a frequency that can be varied;

c) transmitting the high-frequency electrical pulses to a transducer;

d) transducing the high-frequency electrical pulses into mechanical vibrations;

e) pulsating the high-pressure continuous flow waterjet to transform it into a pulsated waterjet of discrete water slugs, each water

slug capable of imparting a waterhammer pressure on a target surface; and

f) directing the pulsated waterjet onto a material to be deburred.

45. A method of removing surface coatings with an ultrasonically pulsed waterjet, the method comprising the steps of:

a) forcing a high-pressure continuous-flow waterjet through a nozzle;

b) generating high-frequency electrical pulses at a frequency that can be varied;

c) transmitting the high-frequency electrical pulses to a transducer;

d) transducing the high-frequency electrical pulses into mechanical vibrations;

e) pulsating the high-pressure continuous flow waterjet to transform it into a pulsated waterjet of discrete water slugs, each water slug capable of imparting a waterhammer pressure on a target surface; and

f) directing the pulsated waterjet onto the surface coating to remove the coating from the surface.

46. A method of cleaning as claimed in claim 45 further comprising the step of self-rotating a rotating nozzle head so that the pulsated waterjet strikes a larger surface area.

47. A method cleaning as claimed in claim 45 further comprising the step of splitting the pulsated waterjet into a plurality of sub-waterjets so that the sub-waterjets strike a larger surface area.

48. A method of breaking rock-like materials with an ultrasonically pulsed waterjet, the method comprising the steps of:

a) forcing a high-pressure continuous-flow waterjet through a nozzle;

b) generating high-frequency electrical pulses at a frequency that can be varied;

c) transmitting the high-frequency electrical pulses to a transducer;

d) transducing the high-frequency electrical pulses into mechanical vibrations;

e) pulsating the high-pressure continuous flow waterjet to transform it into a pulsated waterjet of discrete water slugs, each water slug capable of imparting a waterhammer pressure on a target surface; and

f) directing the pulsated waterjet onto the rock-like material to be broken.